

SPATIO-TEMPORAL VARIABILITY OF ATMOSPHERIC CO₂ AS OBSERVED FROM IN-SITU MEASUREMENTS OVER NORTH AMERICA DURING NASA FIELD CAMPAIGNS (2004-2008)

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ABSTRACT

Regional-scale measurements were made over the eastern United States (Intercontinental Chemical Transport Experiment – North America (INTEX-NA), summer 2004); Mexico (Megacity Initiative: Local and Global Research Observations (MILAGRO), March 2006); the eastern North Pacific and Alaska (INTEX-B May 2006); and the Canadian Arctic (Arctic Research of the Composition of the Troposphere from Aircraft and Satellites (ARCTAS), spring and summer 2008). For these field campaigns, instrumentation for the in situ measurement of CO₂ was integrated on the NASA DC-8 research aircraft providing high-resolution (1 second) data traceable to the WMO CO₂ mole fraction scale. These observations provide unique and definitive data sets via their intermediate-scale coverage and frequent vertical profiles (0.1 – 12 km) for examining the variability CO₂ exhibits above the Earth's surface. A bottom-up anthropogenic CO₂ emissions inventory (1° × 1°) and processing methodology has also been developed for North America in support of these airborne science missions. In this presentation, the spatio-temporal distributions of CO₂ and CO column values derived from the campaign measurements will be examined in conjunction with the emissions inventory and transport histories to aid in the interpretation of the CO₂ observations.

AIRBORNE CO₂ MEASUREMENTS AND COLUMN DATA

In-situ CO₂ measurements were made onboard the NASA DC-8 using a modified non-dispersive infrared gas analyzer and have a precision of 0.1 ppm and an accuracy of ±0.25 ppm.

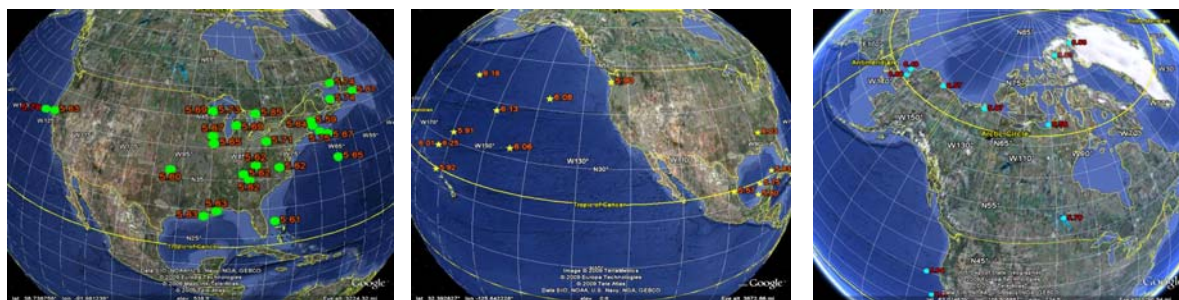


Fig. 1 Spiral locations for INTEX-NA (left), INTEX-B (middle), and ARCTAS (right) and associated integrated column values in E21molec/cm².

Integrated column values derived from ascending or descending spirals executed by the DC-8 during these missions (22 from INTEX-NA, 13 from INTEX-B, and 10 from ARCTAS) were examined from

a secular, seasonal, and geographic perspective. Preliminary results reveal tropospheric column distributions of CO₂ (1 to 10 km) that exhibit variability over land vs ocean during INTEX-NA (~5.6 vs ~5.8 E21 molec/cm²); the Gulf of Mexico vs Pacific Ocean during INTEX-B (~5.8 vs ~6.1 E21 molec/cm²); and latitudinally during ARCTAS (mid (<60°N) vs high latitude(>60°N), ~5.8 vs ~6.4 E21 molec/cm²) as well as seasonally (spring to summer, ~6.7 to ~6.1 E21 molec/cm²) (Fig. 1).

EMISSION INVENTORY AND PROCESSING METHODOLOGY

We developed a global emissions processing system, named KU-EIPS, which can 1) project 120 years of annual emissions (1980-2100); 2) temporally process annual emissions to monthly ones; and 3) speciate pollutants and chemical species. Also, a SMOKE (Sparse Matrix Operator Kernel Emissions)-based regional emission processing system for Asia (i.e. SMOKE-Asia) was developed in

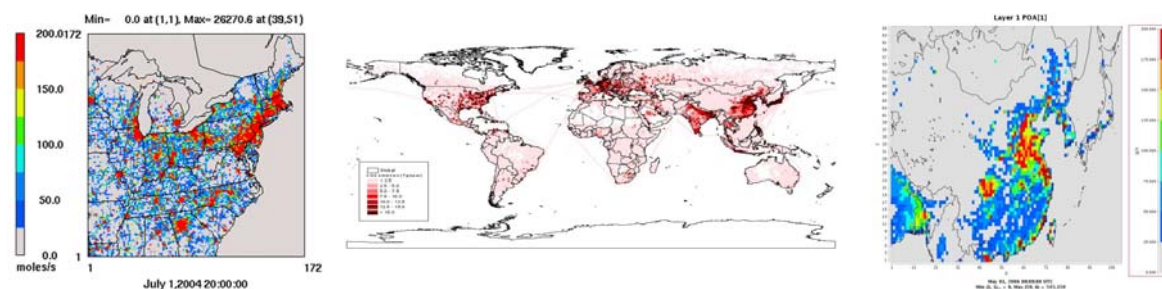


Fig. 2. Modeling emission inventories from Woo et al. (2006, left panel), KU-EIPS (center-panel), and SMOKE-Asia (right panel), respectively.

support of climate-chemistry impact studies. A high-resolution CO₂ modeling emissions inventory from Woo et al. (2006) is being merged on the continental United States region in support of a higher resolution CO₂ emissions-modeling-airborne measurement integration. Inventories from the EDGAR family, Zhang et al. (2009), and Woo et al. (2006) are invoked for the global, Asian, and U.S. domains, respectively (Fig. 2).

Measurements of chemical tracers from the NASA DC-8 (Fig 3, top panel) will be used to validate the high resolution bottom-up emissions inventory. Vertical profile data from the DC-8 flights (Fig 3, bottom panel) will be integrated with a 3-D chemistry model (CMAQ), and satellite/ground-base measurements. Results of the integrated analysis will be presented on site.

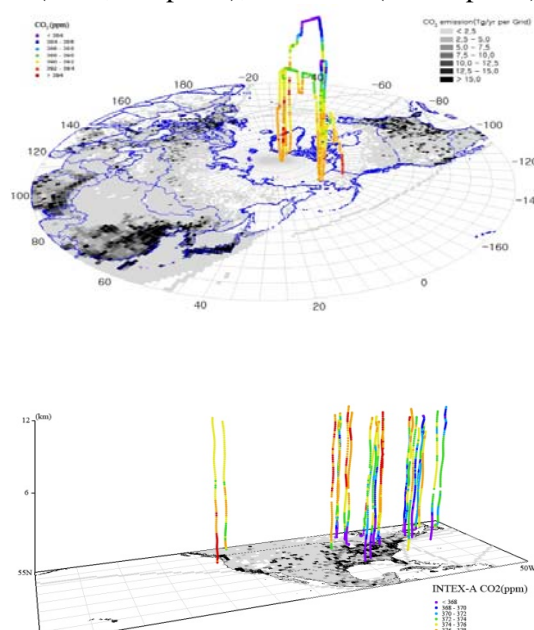


Fig. 3. CO₂ concentrations along an ARCTAS flight path overlaid on CO₂ emissions map (top panel), and INTEX-NA CO₂ vertical profiles (bottom panel).

ACKNOWLEDGEMENTS

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